

BEAR RIVER SOCKEYE SALMON SMOLT ENUMERATION
PROJECT SEASON REPORT, 2002



By

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ABSTRACT

Bear Lake supports the largest sockeye salmon *Oncorhynchus nerka* run along the North Alaska Peninsula within the Alaska Peninsula Management Area. A smolt enumeration project was implemented at Bear River in 2000 to assess sockeye salmon smolt production by estimating the population size, age structure, and physical size of the sockeye salmon smolt emigrating from Bear Lake. The goal of estimating the population size was not achieved for the entire 2002 season. The smolt enumeration portion of the project was difficult to implement at Bear River and many factors made estimation of the smolt population difficult. They included the large size of the smolt, the flow conditions of the river, the migratory behavior of the smolts, and equipment problems. However, limnology and smolt age, weight, and length (AWL) data were collected as planned. Limnology and smolt AWL data suggest Bear River sockeye salmon production is not limited by the amount of available forage.

INTRODUCTION

Bear Lake is located on the north side of the Alaska Peninsula, approximately 25 km east of Port Moller (Figure 1). The lake has a surface area of 25.6 km², a mean depth of 32.3 m and a maximum depth of 104 m (Honnold et al. 1996; Figure 2). Bear River is roughly 30 km in length and drains northwesterly into the Bering Sea. The Bear Lake watershed supports the largest sockeye salmon *Oncorhynchus nerka* runs in the Northern District of the Alaska Peninsula Management Area (Bouwens et al. 2001). There is both an early and late sockeye salmon run to Bear Lake. Ramstad (1998) examined the morphology, life history, and genetic traits of the early and late runs of sockeye salmon at Bear Lake and concluded the two runs were indeed temporally and spatially separate. Total run and return size data to Bear Lake are unavailable because, during the early run, several stocks are harvested concurrently in the area around the outlet of Bear River. However, late run harvest data are available (because there are no other stocks in the area at that time), and over the last 10 years have ranged from 297,000 sockeye salmon in 1998 to 1,150,000 sockeye salmon in 1995 (Murphy et al. 2000).

Over the last 10 years, sockeye salmon escapements have ranged from about 275,000 in 2000 and 2002 to about 465,000 sockeye salmon in 1994, averaging about 356,000. The current escapement goal of 200,000 - 250,000 sockeye salmon to Bear Lake, developed in the late 1960s and early 1970s by area management biologists, was based primarily upon historic escapement data (Bob Murphy, Alaska Department of Fish and Game, Kodiak, personal communication). In the early 1990s, Bear Lake was found to be relatively rich in zooplankton biomass and the smolt produced were robust, indicating the forage base for sockeye salmon was probably underutilized (Honnold et al. 1996). Honnold et al. (1996) concluded that sockeye salmon production was most likely limited by available spawning area, and estimated the spawning area capacity of Bear Lake at 487,000 sockeye salmon. Return per spawner (R/S) calculations were also calculated for Bear Lake, and the number of spawners required to maximize yield was estimated at about 305,000 sockeye salmon, which were estimated to produce a total run of about 1.96 million sockeye salmon (Honnold et al. 1996).

The University of Washington, School of Fisheries and Aquatic Sciences conducted research on Bear Lake sockeye salmon during the summers of 2000 and 2001 (Rogers and Boatright 2002). The goal of this research was to explain the relatively high sockeye salmon production (per unit lake area) of Bear Lake in comparison to other nearby Bristol Bay systems. To reach this goal, the relationship between adult migration date and spawning area of Bear Lake sockeye salmon was investigated via a tagging study. Also, the relationship between spawning date and subsequent juvenile emergence timing of Bear Lake sockeye salmon was investigated. These data are currently being analyzed and will be published in a thesis by Mr. Chris Boatright in May of 2003.

There are multiple methods available to determine escapement goals for a particular system (Honnold and Sagalkin 2001). Euphotic volume (EV) has been used as an indicator of potential sockeye salmon production in many Alaskan sockeye salmon lakes, and may be an appropriate estimator of potential sockeye salmon production in deep, oligotrophic lakes such as Bear Lake (Honnold et al. 1996; Koenings and Kyle 1997). Zooplankton biomass may also be an indicator of sockeye salmon production, but the relationship between zooplankton biomass and smolt biomass production becomes less clear when the lake is not rearing-limited (Koenings and Kyle

1997), although Honnold et al. (1996) considered a zooplankton model appropriate for Bear Lake. These data are being collected as part of this project. Data from this project will be combined with the above information and a formal escapement goal review for Bear Lake will be published separately.

A smolt and limnology project was implemented during 2000 to further assess the potential for sockeye salmon production at Bear Lake. Specifically, data on smolt production and health (length and weight) provide a measure of the rearing capabilities of the system. This goal was to be achieved by addressing the following objectives:

- 1) Estimate the population size of emigrating sockeye salmon smolt from Bear Lake.
- 2) Estimate the mean weight and length, by age, of sockeye salmon smolt emigrating from Bear Lake.
- 3) Measure water temperature and dissolved oxygen profiles, zooplankton abundance and species composition, and the water chemistry of Bear Lake.

This report will summarize the results of these efforts for the 2002 season.

METHODS

Trap Description

In 2000, a rotary screw trap was used to capture smolt emigrating from Bear Lake with little success due to the slow flow conditions of Bear River paired with the relatively large size of Bear River smolts (Bouwens 2001). The large, strong smolts were able to avoid the screw trap and swim against the slow current of the upper Bear River. In 2001, an inclined plane trap was designed and fabricated after Todd (1994) to capture sockeye salmon smolt at Bear River. This trap was again used in 2002 (Figures 3 to 5). The trap was 122 cm wide and 152 cm high at the trap entrance. The trap was 280 cm long and tapered to an exit opening that was 91 cm wide and 30 cm high. A 0.89 m³ live box was attached to the downstream end of the trap. The trap bed consisted of 0.63 cm diameter perforated plate that was bent into four “V” shaped baffles, each of which was approximately 10 cm high and 10 cm wide. The entire inside of the trap was painted black. The sides of the trap were covered with 0.95 cm black plastic mesh.

An additional trap, similar to the inclined plane trap first used in 2001, was used in 2002. This trap was 122 cm wide and 122 cm high at the trap entrance. The trap was 244 cm long. All other dimensions were similar to those of the other trap.

Depending on trap location and configuration, up to two support structures made of 244 cm long by 10 cm high by 10 cm wide wooden timbers were used to allow the vertical adjustment of the downstream end of each trap bed. Each structure consisted of four legs arranged in an angled configuration that supported a cross member that spanned the width of the trap. A pulley was attached to the cross member and a cable was threaded from a winch attached to one of the legs through the pulley on the cross member and attached to the aft end of the trap.

Also depending on trap location and configuration, wings were placed upstream of the trap to direct fish into the trap. The wings were supported by 5 cm diameter schedule 80 piping configured into bipods supporting a cross member. The legs of the bipods were 1.2 m in length and the cross members were 2.4 m in length. Wooden stringers were attached to the upstream legs of the bipods approximately 30 cm from the bottom and 30 cm from the top of the legs. Weir panels were then set on the stringers. At times, perforated aluminum plating (122 cm by 244 cm; 1.5 cm diameter holes) was laid on the weir panels. Plastic mesh (0.95 cm) was laid on the aluminum in a manner that allowed the placement of sandbags along the bottom to seal any holes between the bottom of the aluminum and the substrate.

Trap Placement

From May 19 through June 22, the traps were placed approximately 1 km downstream of the lake outlet (downstream stationary inclined plane trap), as recommended in Bouwens (2001), and as was described in Bouwens (2002). The traps were configured side-by-side with wings extending upstream from the traps. The center of the trap was located approximately 3 m off the northern bank. The offshore lead was 3.65 m long and the inshore lead was 3.04 m in length, and were placed at approximately a 60° angle to the trap mouth (Figure 3). This design was modified several times to account for changing flow conditions, but the general deployment remained similar to the initial set-up.

On June 23, a floating inclined plane trap was designed and installed approximately 0.4 km downstream from the lake outlet. The trap was located approximately 1 m off the north bank of the river, in a high velocity area (~0.5 m/sec). This trap consisted of the smaller inclined plane trap suspended from the pontoons of the rotary screw trap used in 2000 (Figure 4). This trap was installed on June 23 and operated through July 20. It was the primary trapping system from June 23 through July 3.

The river forked into two channels directly downstream of the location of the floating inclined plane trap. On July 2, the stationary inclined plane trap (the larger of the two) was moved and installed approximately 0.5 km downstream of the lake about 3 m off of the northern bank of the southern channel (upstream stationary inclined plane trap; Figure 5). The wings were both 5 m in length and consisted of weir panels only; no perforated plate or plastic mesh was used (Figure 5). This trap became the primary trapping system on July 4 and operated through August 11.

Fish Enumeration

As sockeye salmon smolt emigrated primarily at night, a smolt day was defined as a period from noon to noon, with the date corresponding to the day of the first 12-hour period. All data were recorded in this format. All fish captured were netted out of the trap's catch box, identified based on external characteristics, and counted by species. Salmon smolts were defined as juvenile salmon greater than 45 mm fork length (FL). Salmon less than 45 mm FL were considered fry. Fry and smolt numbers were recorded separately, and catches were tallied individually.

Age, Weight, and Length Sampling

When available, 40 sockeye salmon smolts were sampled for age, weight, and length (AWL) information five days per week. On nights when less than 40 sockeye salmon smolts were captured, all captured smolts were sampled for AWL information. On nights when greater than 40 smolts were captured, a random sample of 40 smolts were collected and sampled for AWL information.

Tricaine methanesulfonate (MS-222) was used to anesthetize smolt prior to sampling. Fork length was measured to the nearest 1 mm, and fish were weighed to the nearest 0.1 g. A sample of 5-10 scales were removed from the preferred area (INPFC 1963) and mounted on a microscope slide for age determination. After sampling, fish were held in aerated water until they recovered from the anesthetic, and were subsequently released downstream from the traps. Age was estimated from scales using a microfiche reader under 36X or 60X magnification. All data were recorded in European notation (Koo 1962).

Condition factor (Bagenal and Tesch 1978) for each smolt sampled was determined using:

$$K = \frac{W}{L^3} 10^5, \quad (1)$$

where K is smolt condition factor, W is weight in g, and L = FL in mm.

Mark Recapture Experiments

A weekly sample (goal = 1,000) of sockeye salmon smolt were marked using Bismark brown dye and released upstream of the traps to estimate the proportion of the total smolt emigration that was being captured in the trap. Fish to be marked were generally collected from the traps, but when trap catch rates were low a fyke net was installed at the weir to collect the sample as described in Bouwens (2001).

Fish to be marked were transferred from the in-stream live box to a transport/marketing tote (113.6 L). The tote was then covered and a water pump was used to slowly exchange the water in the tote for 30 minutes. The circulation pumps were then turned off and 3.8 g of Bismark Brown-Y dye was dissolved in the tote. After 20 minutes in the dye, the pump was started and the tote was flushed with fresh water for 90 minutes.

Smolt showing normal behavior were transported upstream to the release site which was located directly behind the adult weir. At the release site, the smolts were dip netted from the containers, counted, transferred to buckets, and released across the stream. The Bear River smolt population was estimated by using methods described in Carlson et al. (1998).

Limnology Sampling

Limnology samples were taken from Bear Lake on June 11, July 1, and August 2. Water samples were taken on all three dates and zooplankton samples were taken in June and July only. Four

limnology sampling stations were established in Bear Lake (Figure 2) and marked with a buoy. The coordinates of the stations are listed in Table 1. Zooplankton samples, Secchi disk readings along with temperature, dissolved oxygen (DO), and light intensity profiles were taken from all four stations. Water samples were taken from stations 2 and 3. More complete sampling methods and equipment descriptions are found in Bouwens and Newland (2002). Water and zooplankton samples were analyzed following protocol outlined in Koenings et al. (1987) and Thomsen et al. (2002). Sockeye salmon production for Bear Lake was estimated based on EV (Koenings and Burkett 1987) and also estimated based on zooplankton biomass (Koenings and Kyle 1997).

Climate Data

Air and water temperature, wind direction and velocity, and cloud cover and elevation were measured twice daily (1200 and 2400 hours) throughout the field season. Hand held mercury thermometers were used to measure the temperatures. Wind direction and velocity, cloud cover, and cloud elevation were visually estimated by field personnel.

RESULTS

Trap Catches

A total of 1,914 sockeye salmon smolt were captured in the initial downstream stationary inclined plane trap through June 22 (Appendix A). The trap was inoperable for two days (May 23 and 24) and fished marginally on numerous other occasions during this period due to high water. No attempt was made to estimate the number of sockeye salmon smolt missed. This trapping system was then dismantled and used to assemble two other trapping systems. The floating inclined plane trap was installed on June 23 and caught a total of 16,133 sockeye salmon smolt through July 19, when this trap was removed from the water (Appendix B). The upstream stationary inclined plane trap was installed on July 2 and caught a total of 32,685 sockeye salmon smolt before it was removed from the water on August 11(Appendix C).

Data from the downstream stationary trap was unreliable because it did not fish efficiently during rising water events, when most fish were believed to have emigrated. Therefore, catch data from the downstream stationary inclined plane trap from May 19 to June 22 was not included in the final population estimate, and the emigration abundance was only estimated from June 23 to August 11. Although there were multiple trapping systems working, catch numbers from only one trap were used to derive the sockeye salmon smolt population estimate. The two different trapping systems were positioned in such a manner that the same individual fish could have been captured in the upstream trap, released, and then caught again in the downstream trap. Therefore, catch data from the floating inclined plane trap from June 23 to July 3, and the upstream stationary inclined plane trap from July 4 to August 11 were used to generate the smolt population estimate (Table 2).

Age, Weight and Length Sampling

A total of 2,931 sockeye salmon smolt were sampled for AWL data in 2002 (Table 3). The majority (73.0%) of the sockeye salmon smolt sampled were age 1., followed by age 2. smolt (25.9%). There were few age 0. and age 3. sockeye salmon smolt sampled (Table 3). The age compositions of smolt sampled from 1993 to 2002 are listed in Table 4. From 1993 to 2001 age 2. smolt dominated the emigration in all years except 1998. The mean length, weight, and condition factor of sockeye salmon smolt sampled in 2002, by age, are listed in Table 5, and these data are listed with historic data in Table 6. The age 1. smolt at Bear River in 2002 averaged 113 mm in length and 14.2 g in weight; this is the second largest age 1. average length (behind 2001) on record. The age 2. smolt averaged 121 mm in length and 17.0 g in weight, which were largest age 2. smolt (in length) on record. The condition factors of age 1. smolts were slightly higher than those from smolt collected in 2001, while the condition factors of age 2. smolts were lower than those from smolt collected in 2001.

Trap Efficiency Estimates

Mark-recapture experiments were conducted on 10 occasions beginning on June 23 and ending on August 11. Final trap efficiencies ranged from a low of 2.3 percent to a high of 11.0 percent (Table 2).

Sockeye Salmon Smolt Emigration and Timing

The estimated number of sockeye salmon smolt that emigrated between June 23 and August 11 2002 was 746,618 ($\pm 62,320$; 95% C.I.; Table 7). The number that emigrated prior to June 23 or after August 11 is unknown, but is suspected to be substantial prior to June 23. The 2002 measured emigration consisted of 832 age 0., 658,494 age 1., 81,819 age 2., and 5,473 age 3. sockeye salmon smolt (Table 7). The 2002 emigration was characterized by a relatively slow and steady movement of fish with a small increase in fish movement every few days (Figure 6). Age 3. smolt tended to move out of the lake first, followed by age 2. smolt and finally by age 1. smolt (Figure 7).

Limnology Sampling

Bear Lake showed a marked thermocline in 2002, and surface water temperatures at the surface ranged between 6° C in June to 14° C in August (Figure 8). Temperature profiles indicated the lake was mixed in June and was stratified in July and August. Hypolimnetic temperatures ranged from 4° to 6° over the summer. DO levels ranged from 10 to 14 mg/L over the summer (Figure 8). There were no distinct DO discontinuities with depth.

Light intensity and penetration was measured at all stations. Averaged over all stations, the depth to which 1% of the subsurface light penetrated in 2002 was 20.6 m. This equated to an EV of $526 \times 10^6 \text{ m}^3$. Based upon the EV model of Koenings and Burkett (1987), the modeled production of threshold sized smolt (2.5 g) is approximately 12 million fish annually. When the actual mean size of Bear River smolt (11.6 g; age 1. and 2. from 1993 to 2001) was substituted in

the equation, the 2002 modeled smolt production was approximately 3.6 million smolt. Based upon these production levels, the total sockeye salmon return is expected to be about 1.3 million adult sockeye salmon. These data are similar to data collected in 2000 and 2001 (Table 8).

Cyclops and *Bosmina* were the predominant macrozooplankton genera found in Bear Lake in 2002. A large number of rotifers were also observed but they are not considered significant sockeye salmon forage (Tables 9 to 11; Koenings et al. 1987). Koenings and Kyle (1997) developed a model to relate sockeye salmon smolt production to zooplankton abundance. The expected sockeye salmon smolt production of Bear Lake based on this model in 2002 was approximately 1.8 million 11.6 g smolt. Zooplankton biomass was lower in 2002 than in both 2001 and 2000 (Tables 10 to 11).

Surface water samples were taken from stations 2 and 3 (Figure 2). These samples were analyzed for the following parameters: pH, alkalinity, total phosphorus (TP), total filterable phosphorus (TFP), filterable reactive phosphorus (FRP), ammonia, nitrate + nitrite, chlorophyll *a*, and phaeophytin *a* (Table 12). Total phosphorus levels were higher in 2002 than was measured in both 2000 and 2001; measurable nitrogen (ammonia and nitrate+nitrite) levels, however, were lower (Table 13).

Climate Data

Air temperatures ranged from 5 °C on May 29 to 23 °C on August 6; water temperatures ranged from 6 °C on May 25 to 13 °C on August 10 (Figure 9). Stream levels increased with sustained southerly wind events. Wind velocities were highest from the south and the most significant wind event occurred in late May (Figure 9). Air and water temperatures, wind direction and velocity, cloud cover and elevation, and stream height and velocity data are listed in Appendix D.

DISCUSSION

The trap catch data from the beginning of the season to late June were not reliable in 2002. The stream height increased rapidly on multiple occasions (Figure 9, Appendix D) and the trap was not operational for a period of time (Appendix A) during a significant southerly wind event. Sustained southerly winds blow water out of the lake and down the river, increasing stream velocity and height substantially. Past data from 2000 and 2001 indicates that large smolt emigrations often occurred at Bear River during increasing flows (Bouwens 2002). This has also been documented on the Chignik River smolt enumeration project (Bouwens and Edwards 2001). At other times, the trap was operational but fishing with an unknown efficiency. The trap was modified on multiple occasions to deal with fluctuating water levels without associated mark-recapture experiments to determine trap efficiency. In addition, the trap could not be placed in the main current where the majority of the smolts were observed to migrate because substrate under the trap would scour in the high flow conditions (Bouwens 2001, 2002). It is suspected that a significant number of smolts migrated early in the season without being counted and therefore were not included in the estimate for 2002.

Confidence in the data beginning June 23 was higher. The downstream trapping system was dismantled and two independent trapping systems were designed and installed which worked significantly better than the initial system. Mark-recapture experiments were conducted frequently, and the efficiencies for both traps were relatively consistent. Both traps ran concurrently from July 2 to 19 (Appendices B and C). Although results from only one of the traps could be used to estimate the total smolt emigration, the number of smolts estimated to have migrated downstream from the two traps independently during the time they were both fishing was comparable. It was estimated that about 252,000 smolts emigrated out of Bear Lake from July 2 to 19 using data from the floating trap. Using data from the upstream inclined plane trap, it was estimated that 304,000 smolts emigrated out of Bear Lake during the same period.

The partial 2002 smolt population estimate (June 23 through August 11) of 746,000 smolts was much lower than the 2001 smolt population estimate of 1,704,000 smolts during the same time period. Although the 2001 estimate was reasonable in comparison to other ancillary data (Bouwens 2002), the trapping system in 2001 was in a similar location and configuration to where the system was placed in May and June of 2002, with all the same associated problems. Therefore, although the total estimate in 2001 was plausible, comparisons of emigration timing of 2002 with 2001 should be made with caution because of the associated potential error with the 2001 data. The 2001 data do suggest, however, that substantial numbers of smolts can emigrate in June and during high water events in large pulses.

The majority of the smolts sampled in 2002 were age 1. Historically, age 2. smolts tend to predominate the samples from Bear River. The 2002 age 1. smolt were as large as the age 2. smolt usually are (Table 6), indicating healthy rearing conditions for the smolts in the lake during the 2001 growing season. Burgner (1991) noted that, within a watershed, faster growing (larger) juveniles would emigrate to sea earlier than smaller juvenile sockeye salmon. Good growth in their first growing season may have allowed the smolts to leave the lake a year earlier than usual. The average size at age of sockeye salmon smolt varies considerably between watersheds. The average size of Bear River smolts (both length and weight) is extremely large in comparison to other Alaska Peninsula and Kodiak Archipelago Lakes (Honnold et al. 1996; Schrof et al. 2000). The production of relatively few, large sized smolt led Bouwens (2002) to postulate that Bear Lake sockeye salmon (as a population) may experience relatively high marine survival rates.

The transparency of the water and the resultant EZD can be an indicator of sockeye salmon production potential (Koenings and Burkett 1987). The EZD of Bear Lake from 2000 to 2002 was similar ranging from 20.1 to 22.7 m (Table 8). This equated to an estimated production of about 3,500,000 to 4,000,000 11.9 g smolt annually (Table 8; Bouwens 2002; Koenings and Burkett 1987). The recent EZD values were similar to those calculated from data collected in 1993-1995 (19.6 m; Honnold et al. 1996).

As indicated by chlorophyll *a* levels, primary production of Bear Lake has been relatively stable over the last three years (Table 13) and are similar to data collected in 1993-1995 (Honnold et al. 1996). Generally, phosphorus levels limit lake productivity (Koenings et al. 1987). Interestingly, total phosphorus levels have increased from 3.7 ug/L in 1993-1995 (Honnold et al. 1996) to 56.3 ug/L in 2002 (Table 13), which may indicate a higher potential for sockeye salmon production in recent years. However, the laboratory tests for total phosphorus are extremely sensitive, and it is possible that the 2002 samples were contaminated.

The 2002 zooplankton level, in terms of biomass, was reduced in comparison to 2001 and 2000 (Tables 10 and 11). Part of this apparent drop may be a result of limited sampling in 2002. Generally, cladoceran abundance increases in the late summer and fall. No zooplankton samples were taken after July in 2002. The zooplankton biomass for the past three summers were low (383-678 mg/m²) in comparison to data collected in 1993-1995 (1,217 mg/m²; Honnold et al. 1996). The resultant smolt, however, were all large and robust, indicating that the zooplankton forage base was not limiting sockeye salmon production in Bear Lake.

SUMMARY

A project has been conducted at Bear River from 2000 to 2002 to attempt to estimate the total population size of emigrating sockeye smolts from Bear Lake. A smolt enumeration project was difficult to successfully conduct at Bear River. Many factors made estimation of the smolt population size difficult. The large size of the smolt made them difficult to catch because they could easily avoid the traps. The river is relatively slow and the substrate is loose and eroded easily, which made it difficult to hold a trapping system in place. The smolts tended to emigrate when there were strong southerly winds, which increased flows and often compromised the traps. The associated limnology and smolt AWL data however, were extremely valuable and will be used in an escapement goal review for Bear Lake.

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Table 1. Coordinates and types of samples taken from the four limnology stations located in Bear Lake, 2002.

Station	Latitude	Longitude	Sample taken ^a
1	55° 58.574' N	160° 12.092' W	Z, L, T
2	55° 59.092' N	160° 12.092' W	Z, L, T, H2O
3	55° 59.935' N	160° 13.666' W	Z, L, T, H2O
4	56° 00.901' N	160° 14.310' W	Z, L, T

^a Z = zooplankton, L = light intensity profiles, T = temperature, DO, and Sechi profiles, H2O = water quality samples.

Table 2. Daily and cumulative sockeye salmon trap catches and corresponding mark-recapture data for the Bear River smolt project, by smolt day, 2002.

Smolt date	Catch ^a		Mark-recapture			% ^b
	Daily	Cumulative	No. released	Daily recaptures	Cumulative recaptures	
6/23	387	387	1,000	61	61	6.2%
6/24	338	725		3	64	6.5%
6/25	1,283	2,008	1,000	49	49	5.0%
6/26	1,264	3,272		6	55	5.6%
6/27	1,872	5,144	1,000	18	18	1.9%
6/28	781	5,925		2	20	2.1%
6/29	920	6,845		2	22	2.3%
6/30	992	7,837	920	25	25	2.8%
7/1	205	8,042		6	31	3.5%
7/2	139	8,181		1	32	3.6%
7/3	283	8,464		2	34	3.8%
7/4	653	9,117	1,000	61	61	6.2%
7/5	319	9,436		7	68	6.9%
7/6	718	10,154		5	73	7.4%
7/7	925	11,079	1,000	49	49	5.0%
7/8	1,568	12,647		19	68	6.9%
7/9	440	13,087		2	70	7.1%
7/10	483	13,570		0	70	7.1%
7/11	2,005	15,575		0	70	7.1%
7/12	4,788	20,363		0	70	7.1%
7/13	705	21,068	1,000	83	83	8.4%
7/14	295	21,363		18	101	10.2%
7/15	3,586	24,949		6	107	10.8%
7/16	922	25,871		2	109	11.0%
7/17	947	26,818	950	34	34	3.7%
7/18	1,014	27,832		6	40	4.3%
7/19	1,629	29,461		1	41	4.4%
7/20	67	29,528		0	41	4.4%
7/21	243	29,771		0	41	4.4%
7/22	189	29,960		0	41	4.4%
7/23	2,039	31,999		0	41	4.4%
7/24	1,692	33,691	1,000	86	86	8.7%
7/25	678	34,369		0	86	8.7%
7/26	304	34,673		1	87	8.8%
7/27	204	34,877		1	88	8.9%
7/28	144	35,021		1	89	9.0%
7/29	239	35,260		1	90	9.1%
7/30	914	36,174		0	90	9.1%
7/31	663	36,837		0	90	9.1%
8/1	346	37,183	450	8	8	2.0%
8/2	950	38,133		2	10	2.4%
8/3	127	38,260		1	11	2.7%
8/4	254	38,514		0	11	2.7%
8/5	351	38,865		0	11	2.7%

-Continued-

Table 2. (Page 2 of 2)

Smolt date	Catch		Mark-			% ^a
	Daily	Cumulative	No. released	Daily recaptures	Cumulative recaptures	
8/6	78	38,943		0	11	2.7%
8/7	129	39,072		0	11	2.7%
8/8	736	39,808		0	11	2.7%
8/9	362	40,170		0	11	2.7%
8/10	128	40,298		0	11	2.7%
8/11	429	40,727		0	11	2.7%

^a Catch data from 6/23 to 7/3 were obtained from the floating inclined plane trap, while catch data from 7/4 to 8/11 were obtained from the stationary inclined plane trap.

^b Calculated by: $\% = \{(M+1)/(R+1)\} * 100$;
 where: M = number of marked fish, and;
 R = number of marked fish recaptured (Carlson et al. 1998).

Table 3. Age composition of Bear River sockeye salmon smolt samples by week, 2002.

Week	Week Ending	Sample Size		Ages				Total
				0	1	2	3	
21	23-May	44	Percent	0.0	0.0	97.7	2.3	100.0
			Numbers	0	0	43	1	44
22	30-May	40	Percent	0.0	15.0	85.0	0.0	100.0
			Numbers	0	6	34	0	40
23	6-Jun	39	Percent	0.0	15.4	84.6	0.0	100.0
			Numbers	0	6	33	0	39
24	13-Jun	243	Percent	0.0	26.3	72.0	1.6	100.0
			Numbers	0	64	175	4	243
25	20-Jun	360	Percent	0.0	51.7	46.9	1.4	100.0
			Numbers	0	186	169	5	360
26	27-Jun	480	Percent	0.0	71.7	26.2	2.1	100.0
			Numbers	0	344	126	10	480
27	4-Jul	400	Percent	0.2	74.0	23.8	2.0	100.0
			Numbers	1	296	95	8	400
28	11-Jul	360	Percent	0.0	86.4	13.3	0.3	100.0
			Numbers	0	311	48	1	360
29	18-Jul	200	Percent	0.0	88.5	10.5	1.0	100.0
			Numbers	0	177	21	2	200
30	25-Jul	200	Percent	0.5	97.0	2.5	0.0	100.0
			Numbers	1	194	5	0	200
31	1-Aug	200	Percent	0.0	97.5	2.5	0.0	100.0
			Numbers	0	195	5	0	200
32	8-Aug	199	Percent	0.0	98.0	2.0	0.0	100.0
			Numbers	0	195	4	0	199
33	15-Aug	80	Percent	0.0	100.0	0.0	0.0	100.0
			Numbers	0	80	0	0	80
34	22-Aug	86	Percent	0.0	98.8	1.2	0.0	100.0
			Numbers	0	85	1	0	86
Total			Percent	0.1	73.0	25.9	1.1	100.0
			Numbers	2	2,139	759	31	2,931

Table 4. Age composition of Bear River sockeye salmon smolt samples taken from 1993 to 2002.

Year	Dates		Ages					Total
			0	1	2	3	4	
1993	06/01-08/02	Percent	0.0	7.6	92.3	0.1	0.0	100
		Numbers	0	121	1,465	1	0	1,587
1994	06/08-07/20	Percent	0.0	9.7	87.3	3.0	0.0	100
		Numbers	0	125	1,120	38	0	1,283
1995	06/15-07/23	Percent	0.1	12.0	87.8	0.1	0.0	100
		Numbers	1	123	896	1	0	1,021
1996	06/12-07/17	Percent	0.3	7.6	91.9	0.2	0.0	100
		Numbers	2	46	554	1	0	603
1997	06/23-08/15	Percent	0.1	43.7	56.1	0.1	0.0	100
		Numbers	1	542	696	1	0	1,240
1998	06/20-08/21	Percent	0.0	55.3	44.7	0.1	0.0	100
		Numbers	0	787	636	1	0	1,424
1999	06/13-08/24	Percent	0.0	1.6	97.9	0.5	0.0	100
		Numbers	1	33	2,013	10	0	2,057
2000	05/18-08/15	Percent	0.6	31.9	66.9	0.6	0.0	100
		Numbers	12	682	1,428	12	1	2,135
2001	05/18-08/15	Percent	0.4	40.5	54.1	4.9	0	100
		Numbers	8	777	1,038	94	0	1,917
2002	05/19-08/22	Percent	0.1	73.0	25.9	1.1	0	100
		Numbers	2	2,139	759	31	0	2,931
Total		Percent	0.2	33.2	65.5	1.2	0.0	100.0
		Numbers	27	5,375	10,605	190	1	16,198

Table 5. Mean length, weight, and condition factor of Bear River sockeye salmon smolt samples by age and week, 2002.

Age	Week	Length (mm)			Weight (g)			Condition		
		Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error	Sample Size	Mean	Standard Error
0	27	1	75	NA	1	3.4	NA	1	0.81	NA
0	30	1	105	NA	1	9.3	NA	1	0.8	NA
Total		2	90	15.0	2	6.4	2.95	2	0.80	0.001
1	22	6	97	6.9	6	8.6	2.04	6	0.84	0.052
1	23	6	109	3.8	6	11.5	1.10	6	0.88	0.022
1	24	64	106	1.0	64	11.1	0.30	64	0.91	0.008
1	25	186	108	0.6	186	12.1	0.20	186	0.95	0.005
1	26	343	111	0.4	343	12.8	0.14	343	0.93	0.003
1	27	296	109	0.4	296	12.8	0.12	296	0.99	0.006
1	28	311	114	0.4	311	14.7	0.16	311	0.99	0.004
1	29	177	119	0.6	177	16.9	0.29	177	0.99	0.006
1	30	194	119	0.4	194	15.8	0.16	194	0.95	0.005
1	31	195	115	0.7	195	14.8	0.28	195	0.94	0.004
1	32	195	117	0.6	195	15.6	0.24	195	0.97	0.004
1	33	80	119	0.8	80	15.9	0.34	80	0.93	0.008
1	34	85	114	0.9	84	14.2	0.34	84	0.95	0.006
Total		2,138	113	0.2	2,137	14.2	0.07	2,137	0.96	0.002
2	21	43	125	2.1	32	17.2	1.03	32	0.84	0.015
2	22	34	128	1.9	34	18.8	0.99	34	0.87	0.016
2	23	33	122	1.6	33	16.2	0.62	33	0.87	0.015
2	24	175	118	0.7	175	14.8	0.29	175	0.89	0.006
2	25	169	117	0.8	169	15.2	0.34	169	0.93	0.007
2	26	126	125	1.6	126	18.7	0.73	126	0.92	0.008
2	27	95	126	2.1	95	20.6	1.03	95	0.97	0.012
2	28	48	123	2.6	48	19.1	1.27	48	0.99	0.020
2	29	21	124	2.3	21	18.1	1.29	21	0.93	0.027
2	30	5	117	1.9	5	14.7	0.98	5	0.91	0.060
2	31	5	116	3.4	5	15.2	1.39	5	0.96	0.024
2	32	4	119	3.8	4	17.4	1.82	4	1.02	0.015
2	34	1	120	NA	1	16.0	NA	1	0.93	NA
Total		759	121	0.5	748	17.0	0.25	748	0.92	0.004
3	21	1	150	NA	1	30.7	NA	1	0.91	NA
3	24	4	134	9.2	4	24.1	4.22	4	0.98	0.039
3	25	5	137	4.3	5	24.9	2.08	5	0.96	0.014
3	26	10	149	5.0	10	31.6	2.85	10	0.94	0.022
3	27	8	162	5.5	8	38.2	2.62	8	0.90	0.034
3	28	1	172	NA	1	39.2	NA	1	0.77	NA
3	29	2	186	10.5	2	61.2	7.30	2	0.96	0.048
Total		31	152	3.5	31	33.4	2.08	31	0.93	0.014

Table 6. Mean length, weight, and condition factor of sockeye salmon smolt samples taken from Bear River, by age and year, 1993 to 2002.

Age	Year	Length			Weight			Condition		
		n	Mean	SE	n	Mean	SE	n	Mean	SE
0	1996	2	75	6.0	2	3.2	0.15	2	0.77	0.146
0	1997	1	96	NA	1	8.2	NA	1	0.93	NA
0	1999	1	67	NA	1	2.4	NA	1	0.80	NA
0	2000	12	71	3.4	12	3.6	0.45	12	0.95	0.056
0	2001	8	73	2.2	8	3.8	0.34	8	0.96	0.042
0	2002	2	90	15.0	2	6.4	2.95	2	0.80	0.001
1	1993	121	90	0.7	119	7.2	0.15	119	0.97	0.012
1	1994	125	99	0.9	125	9.5	0.22	125	0.97	0.007
1	1995	123	105	0.9	123	11.5	0.30	123	0.97	0.008
1	1996	46	102	1.7	46	10.0	0.43	46	0.93	0.017
1	1997	539	106	0.4	539	12.0	0.12	539	1.00	0.003
1	1998	786	105	0.3	787	10.8	0.09	786	0.91	0.002
1	1999	33	94	1.6	33	7.2	0.38	33	0.84	0.013
1	2000	682	106	0.4	682	12.7	0.13	682	1.03	0.005
1	2001	777	117	0.3	777	16.3	0.13	777	1.00	0.003
1	2002	2,138	113	0.2	2,137	14.2	0.07	2,137	0.96	0.002
2	1993	1,464	98	0.2	1,458	9.1	0.05	1,457	0.96	0.003
2	1994	1,114	108	0.3	1,118	12.0	0.08	1,112	0.95	0.002
2	1995	895	112	0.3	893	13.7	0.09	892	0.96	0.003
2	1996	554	113	0.4	550	13.6	0.12	550	0.92	0.004
2	1997	695	115	0.2	695	14.3	0.08	695	0.94	0.003
2	1998	636	114	0.5	635	13.6	0.14	635	0.91	0.002
2	1999	2,013	103	0.2	2,013	9.4	0.05	2,013	0.86	0.001
2	2000	1,428	110	0.2	1,428	13.9	0.08	1,428	1.02	0.003
2	2001	1,038	121	0.3	1,038	17.5	0.14	1,038	0.96	0.003
2	2002	759	121	0.5	748	17.0	0.25	748	0.92	0.004
3	1993	1	118	NA	1	14.1	NA	1	0.86	NA
3	1994	38	113	1.5	38	13.8	0.48	38	0.93	0.009
3	1995	1	135	NA	1	21.3	NA	1	0.87	NA
3	1996	1	115	NA	1	14.8	NA	1	0.97	NA
3	1997	1	125	NA	1	18.0	NA	1	0.92	NA
3	1998	1	130	NA	1	18.0	NA	1	0.82	NA
3	1999	10	139	4.5	10	24.7	2.45	10	0.89	0.011
3	2000	12	133	3.4	12	23.3	1.90	12	0.98	0.031
3	2001	94	131	1.5	94	22.1	0.78	94	0.94	0.009
3	2002	31	152	3.5	31	33.4	2.08	31	0.93	0.014
4	2000	1	161	NA	1	42.9	NA	1	1.03	NA

Table 7. Bear River sockeye salmon smolt population estimates, by age and date, 2000 to 2002.

Year	Estimate Dates		Number of Smolt					S.E.	95% C.I	
			Age 0	Age 1	Age 2	Age 3	Total		Lower	Upper
2000			Estimate Not Possible							
2001	May 23 - August 9	Numbers	3,414	1,132,508	2,022,820	176,633	3,335,375	1,146,339	1,090,285	5,583,935
		Percent	0.1	34.0	60.6	5.3	100.0			
2002 ^a	June 22 - August 11	Numbers	832	658,494	81,819	5,473	746,618	31,796	684,297	808,938
		Percent	0.1	88.2	11.0	0.7	100.0			

^a This time period represents only a portion of the smolt emigration season. It is probable that a large portion of the emigration was missed prior to June 22 due to equipment difficulties.

Table 8. Modeled sockeye salmon escapement, smolt production, and adult production based on euphotic volume (EV) calculations from Bear Lake, 2000 to 2002.

Year	EZD (m)	EV ($\times 10^6 \text{ m}^3$)	Optimal Escapement		Smolt Production		Adult Production
			Lower	Upper	Threshold Sized	Bear Average ^a	
2000	22.7	581	465,000	523,000	13,400,000	4,000,000	1,450,000
2001	20.1	515	412,000	463,000	11,800,000	3,500,000	1,290,000
2002	20.6	526	421,000	474,000	12,100,000	3,600,000	1,320,000

Calculations based on Koenings and Burkett (1987).

^a Assuming an average age 1 and 2 smolt weight of 11.9 g and 81 kg smolt production per EV unit.

Table 9. Average number of zooplankton per m³ and m² from Bear Lake, over all stations, 2000 to 2002.

Taxon	Mean (Stations 1-4) Macrozooplankton Density									
	(no./m ³)					(no./m ²)				
	6/11/02	7/1/02	00 Mean	01 Mean	02 Mean	6/11/02	7/1/02	00 Mean	01 Mean	02 Mean
Copepods:										
<i>Epischura</i>	18	0	7	11	9	398	0	199	597	199
<i>Diaptomus</i>	0	35	0	0	17	0	2,079	0	0	1,039
<i>Cyclops</i>	4,153	3,850	3,835	2,951	4,002	220,566	224,847	189,391	165,365	222,707
Ovig. <i>Cyclops</i>	62	72	314	63	67	3,583	4,160	13,951	3,425	3,871
<i>Harpacticus</i>	18	0	0	0	9	398	0	0	0	199
Nauplii	388	771	217	214	579	21,522	45,734	10,699	11,827	33,628
Total Copepods	4,638	4,727	4,373	3,240	4,682	246,467	276,820	214,239	181,214	261,644
Cladocerans:										
<i>Bosmina</i>	127	114	2,414	561	120	6,568	6,721	122,894	7,121	6,645
Ovig. <i>Bosmina</i>	26	8	181	42	17	1,418	405	8,277	1,283	911
<i>Daphnia l.</i>	0	30	6	0	15	0	1,814	332	0	907
<i>Chydorinae</i>	0	0	0	11	0	0	0	0	885	0
Imm. Cladocera	25	0	245	43	12	0	0	14,149	796	0
Total Cladocerans	178	152	2,845	657	165	7,987	8,939	145,651	10,085	8,463
Total Cope.+Clad.	4,815	4,879	7,218	3,897	4,847	254,453	285,759	359,890	191,298	270,106
Rotifers:										
<i>Kellicottia</i>	4,483	6,336	5,145	5,287	5,409	247,412	350,418	212,961	305,724	298,915
<i>Asplanchna</i>	63	243	126	7	153	3,251	14,530	4,562	382	8,891
<i>Keratella</i>	49	422	26	305	236	2,687	25,345	1,144	17,823	14,016
<i>Conochilus</i>	3,726	1,778	0	2	2,752	223,577	80,016	0	11	151,796
Other Rotifers	891	321	31,934	23	606	40,970	19,241	1,323,149	1,302	30,105
Total Rotifers	9,212	9,100	37,231	5,624	9,156	517,897	489,550	1,541,816	325,347	503,724

Table 10. Biomass estimates (mg dry weight/m³) of the major zooplankton species, by sample date, for Bear Lake, 2000 to 2002.

Taxon	Sample Date				
	6/11/02	7/1/02	00 Mean	01 Mean	02 Mean
Copepods:					
<i>Cyclops</i>	6.16	6.24	9.65	8.17	6.20
<i>Diaptomus</i>	0.00	0.25	0	0	0.13
<i>Epischura</i>	0.06	0.00	0	0	0.03
Total copepods	6.22	6.49	9.65	8.17	6.36
Cladocerans:					
<i>Bosmina</i>	0.39	0.58	5.81	1.54	0.49
<i>Daphnia l.</i>	0.00	0.08	0	0	0.04
Total cladocerans	0.39	0.66	5.81	1.54	0.53
Copepods:Cladocerans	16	10	2	5	12
Total Biomass	6.61	7.15	15.46	9.71	6.88

Table 11. Biomass estimates (mg dry weight/m²) of the major zooplankton species, by sample date, for Bear Lake, 2000 to 2002.

Taxon	Sample Date				
	6/11/02	7/1/02	00 Mean	01 Mean	02 Mean
Copepods:					
<i>Cyclops</i>	328.00	364.31	392.47	451.63	346.16
<i>Diaptomus</i>	0.00	14.95	0	0	7.48
<i>Epischura</i>	1.29	0.00	0	0.07	0.65
Total copepods	329.29	379.26	392.47	451.70	354.28
Cladocerans:					
<i>Bosmina</i>	20.44	33.53	285.95	82.14	26.99
<i>Daphnia l.</i>	0.00	4.87		0	2.44
Total cladocerans	20.44	38.40	285.95	82.14	29.42
Copepods:Cladocerans	16	10	2	5	12
Total Biomass	349.73	417.66	678.42	533.84	383.70

Table 12. Surface (1 m) water quality data taken from stations 2 and 3 from Bear Lake, 2002.

Date	Sta	Water Sample Depth	Secchi	pH	Alkalinity (mg/L)	Total P (ug/L P)	TFP (ug/L P)	FRP (ug/L P)	Ammonia (ug/L N)	Nitrate + Nitrite (ug/L N)	Chloro-phyll a (ug/L)	Phaeo-phytin a (ug/L)
6/11	2	1 m	NA	7.2	14	9.8	2.6	2.3	4.0	74.0	0.64	0.93
7/1	2	1 m	NA	7.2	19	6.7	5.3	3.7	3.8	34.9	0.64	0.48
8/2	2	1 m	6.8	7.3	18	10.4	7.6	7.2	4.5	38.1	NA	NA
Mean			6.8	7.2	17.0	9.0	5.2	4.4	4.1	49.0	0.64	0.71
STDV			NA	0.1	2.6	2.0	2.5	2.5	0.4	21.7	0.00	0.32
6/11	3	1 m	NA	7.1	15.0	115.3	8.9	5.8	3.4	65.4	0.96	0.38
7/1	3	1 m	NA	7.2	14.0	188.4	8.1	5.0	6.5	54.3	0.96	0.16
8/2	3	1 m	8.8	7.3	14.0	7.4	16.9	12.5	8.8	46.0	NA	NA
Mean			8.8	7.2	14.3	103.7	11.3	7.8	6.2	55.2	0.96	0.27
STDV			NA	0.1	0.6	91.1	4.9	4.1	2.7	9.7	0.00	0.16
Mean over stations 2,3												
6/11	2,3	1 m	NA	7.2	14.5	62.6	5.8	4.1	3.7	69.7	0.80	0.66
7/1	2,3	1 m	NA	7.2	16.5	97.6	6.7	4.4	5.2	44.6	0.80	0.32
8/2	2,3	1 m	7.8	7.3	16.0	8.9	12.3	9.9	6.7	42.1	NA	NA
Mean			7.8	7.2	15.7	56.3	8.2	6.1	5.2	52.1	0.80	0.49
STDV			NA	0.0	1.0	44.7	3.5	3.3	1.5	15.3	0.00	0.24

Table 13. Average surface (1 m) water quality data taken from stations 2 and 3 from Bear Lake, 2000 to 2002.

Date	Sta	Water Sample Depth	Secchi	pH	Alkalinity (mg/L)	Total P (ug/L P)	TFP (ug/L P)	FRP (ug/L P)	Ammonia (ug/L N)	Nitrate + Nitrite (ug/L N)	Chloro- phyll a (ug/L)	Phaeo- phytin a (ug/L)
2000												
6/30/2000	2,3	1 m	8.0	7.5	8.5	2.4	0.7	2.5	2.4	115.9	0.96	0.50
7/25/2000	2,3	1 m	6.8	7.4	7.8	18.2	13.9	1.9	3.3	46.7	0.80	0.55
8/21/2000	2,3	1 m	3.6	7.4	8.5	6.6	0.7	2.0	3.0	41.0	0.96	0.24
2000 Mean			6.1	7.4	8.3	9.0	5.1	2.1	2.9	67.9	0.91	0.43
2000 STDV			2.3	0.1	0.4	8.2	7.6	0.3	0.4	41.7	0.09	0.16
2001												
5/25/2001	2,3	1 m	8.9	7.3	15.5	15.7	9.2	5.8	2.9	101.2	2.1	0.04
6/29/2001	2,3	1 m	7.4	7.3	18.5	10.0	5.9	8.8	2.7	115.3	1.4	0.17
7/27/2001	2,3	1 m	6.6	7.1	14.5	13.6	7.6	11.0	2.5	71.0	1.0	0.10
8/11/2001	2,3	1 m	6.7	7.2	21.5	10.6	5.1	25.2	5.0	74.0	0.8	0.43
2001 Mean			7.4	7.2	17.5	12.4	6.9	12.7	3.3	90.3	1.32	0.18
2001 STDV			1.1	0.1	3.2	2.6	1.8	8.6	1.2	21.5	0.6	0.17
2002												
6/11/2002	2,3	1 m		7.2	14.5	62.6	5.8	4.1	3.7	69.7	0.80	0.66
7/1/2002	2,3	1 m		7.2	16.5	97.6	6.7	4.4	5.2	44.6	0.80	0.32
8/2/2002	2,3	1 m	7.8	7.3	16.0	8.9	12.3	9.9	6.7	42.1		
2002 Mean			7.8	7.2	15.7	56.3	8.2	6.1	5.2	52.1	0.80	0.49
2002 STDV			NA	0.0	1.0	44.7	3.5	3.3	1.5	15.3	0.00	0.24

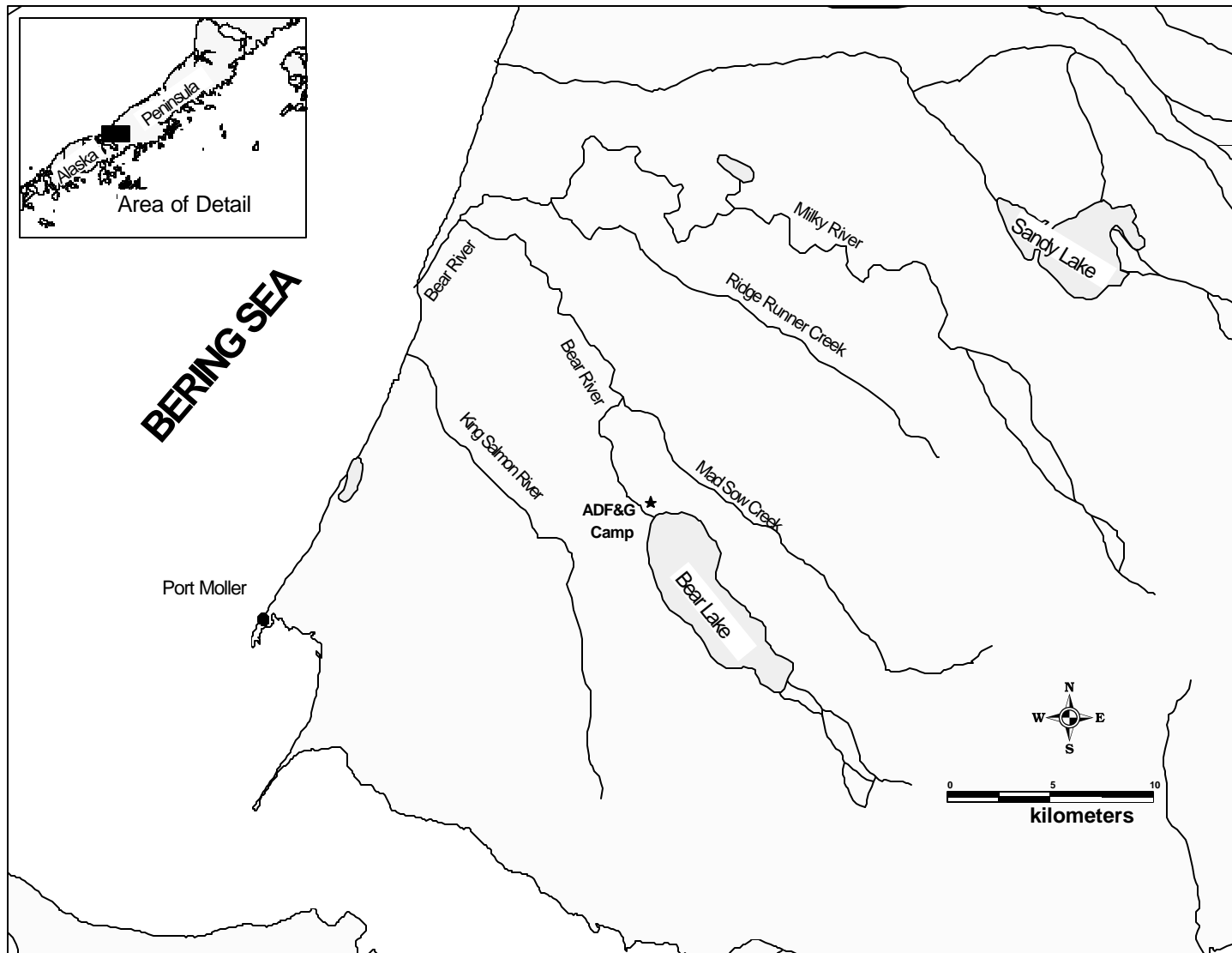


Figure 1. Map of the Bear Lake area on the Alaska Peninsula.

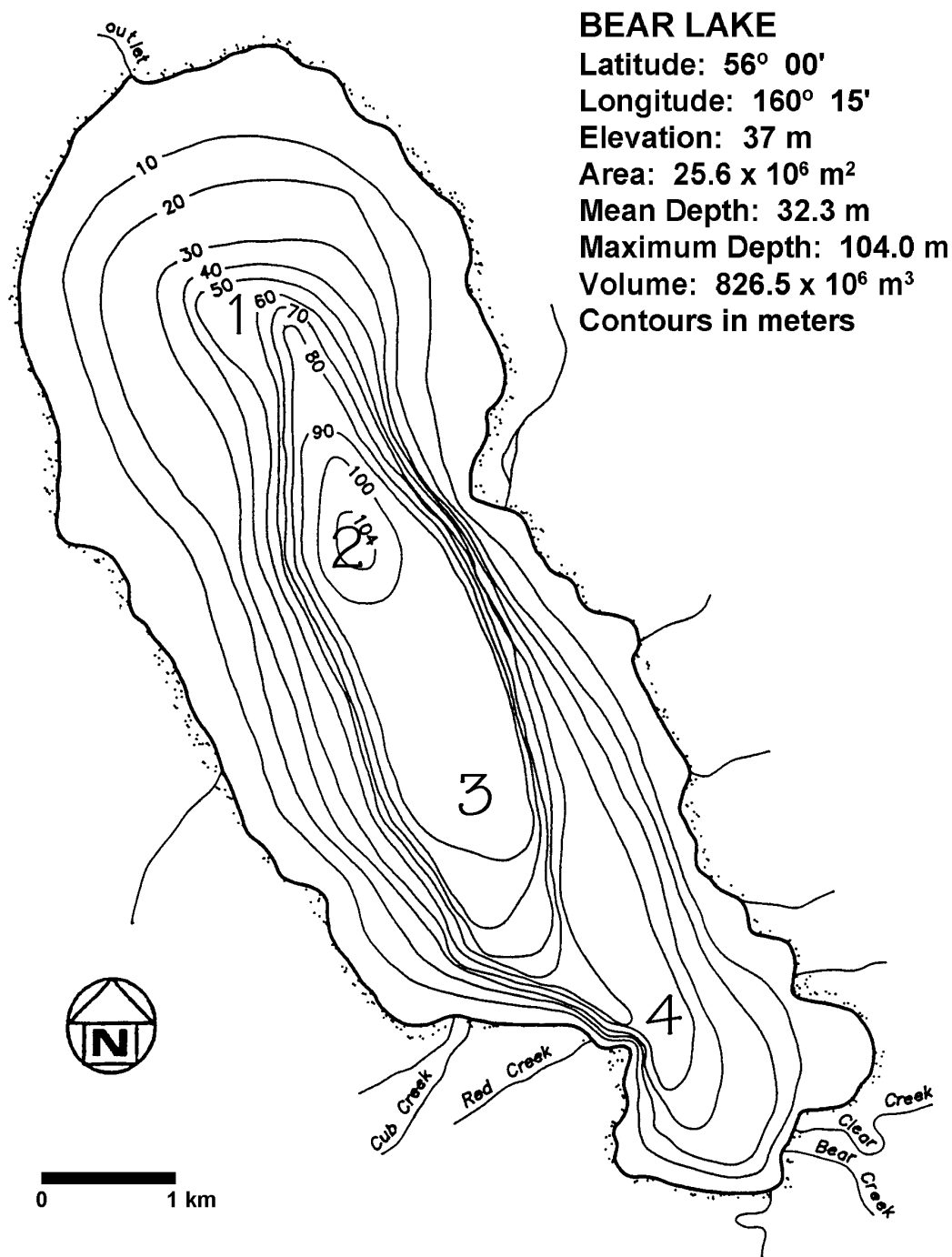


Figure 2. Bathymetric map of Bear Lake showing the locations of the limnology stations (1-4).

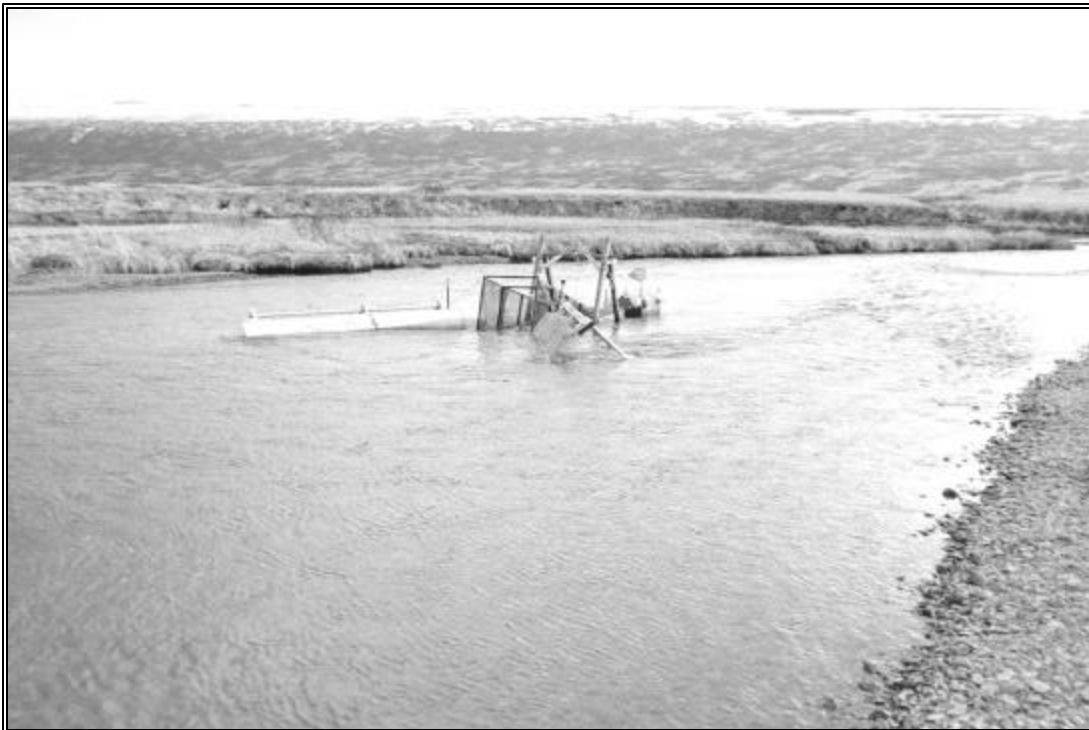


Figure 3. Photographs of different configurations of the downstream inclined plane trap used in 2002.



Figure 4. Photographs of the floating inclined plane trap used in 2002.



Figure 5. Photographs of the upstream inclined plane trap used in 2002.

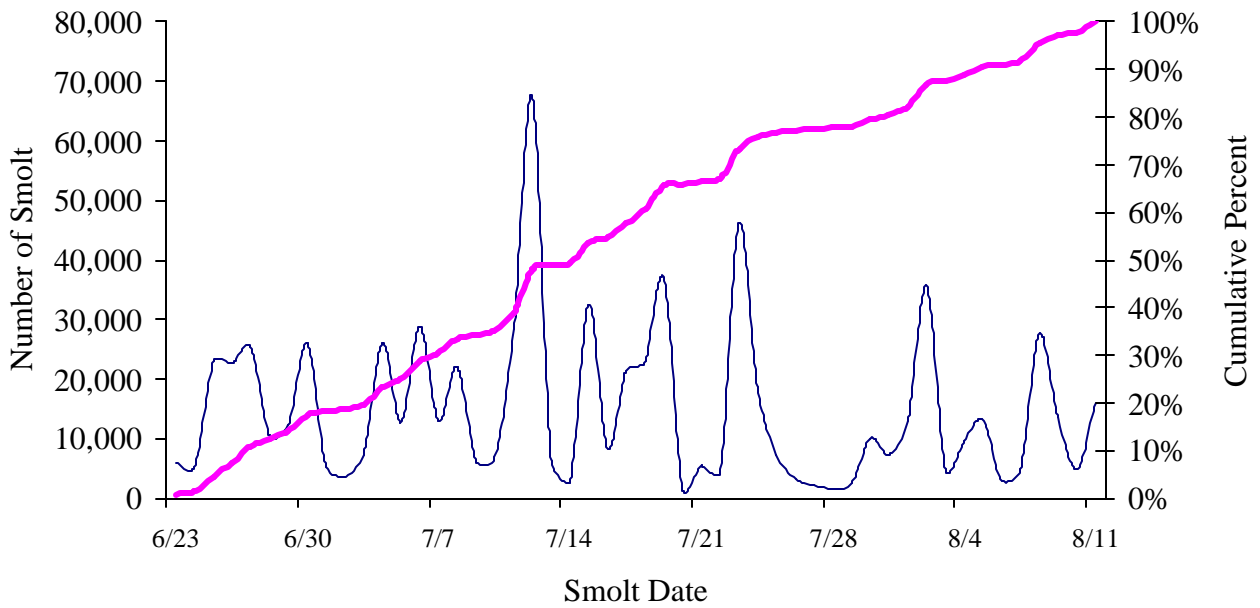


Figure 6. Estimated daily sockeye salmon smolt emigration and cumulative percentage, by day, for Bear River, 2002.

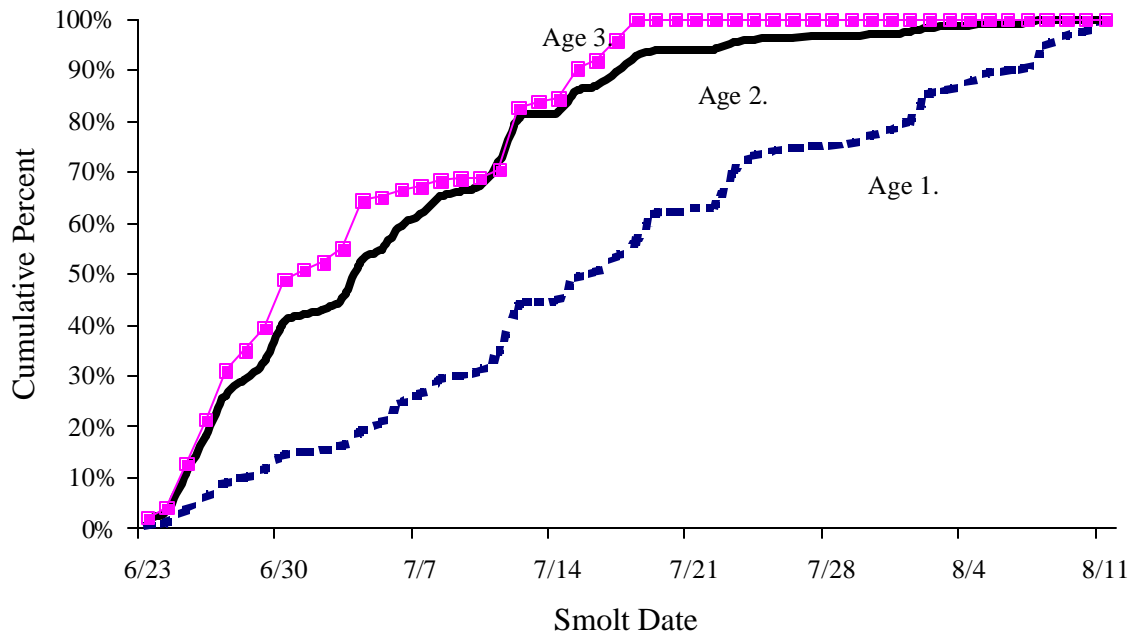


Figure 7. Cumulative percentage of the estimated number of sockeye salmon smolt emigrating from Bear Lake, by age and day, 2002.

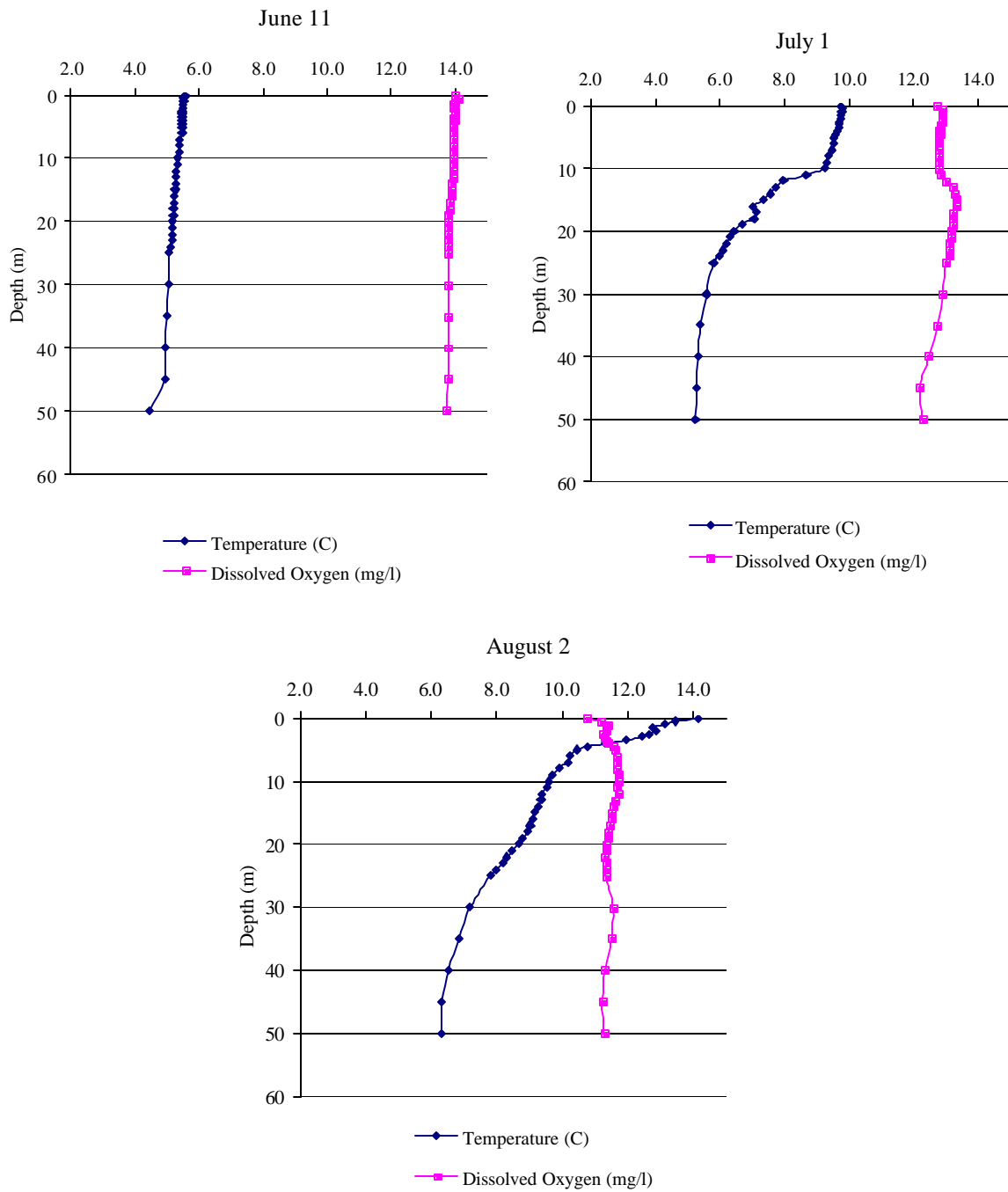


Figure 8. Mean temperature and dissolved oxygen profiles measured in Bear Lake, June through August, 2002.

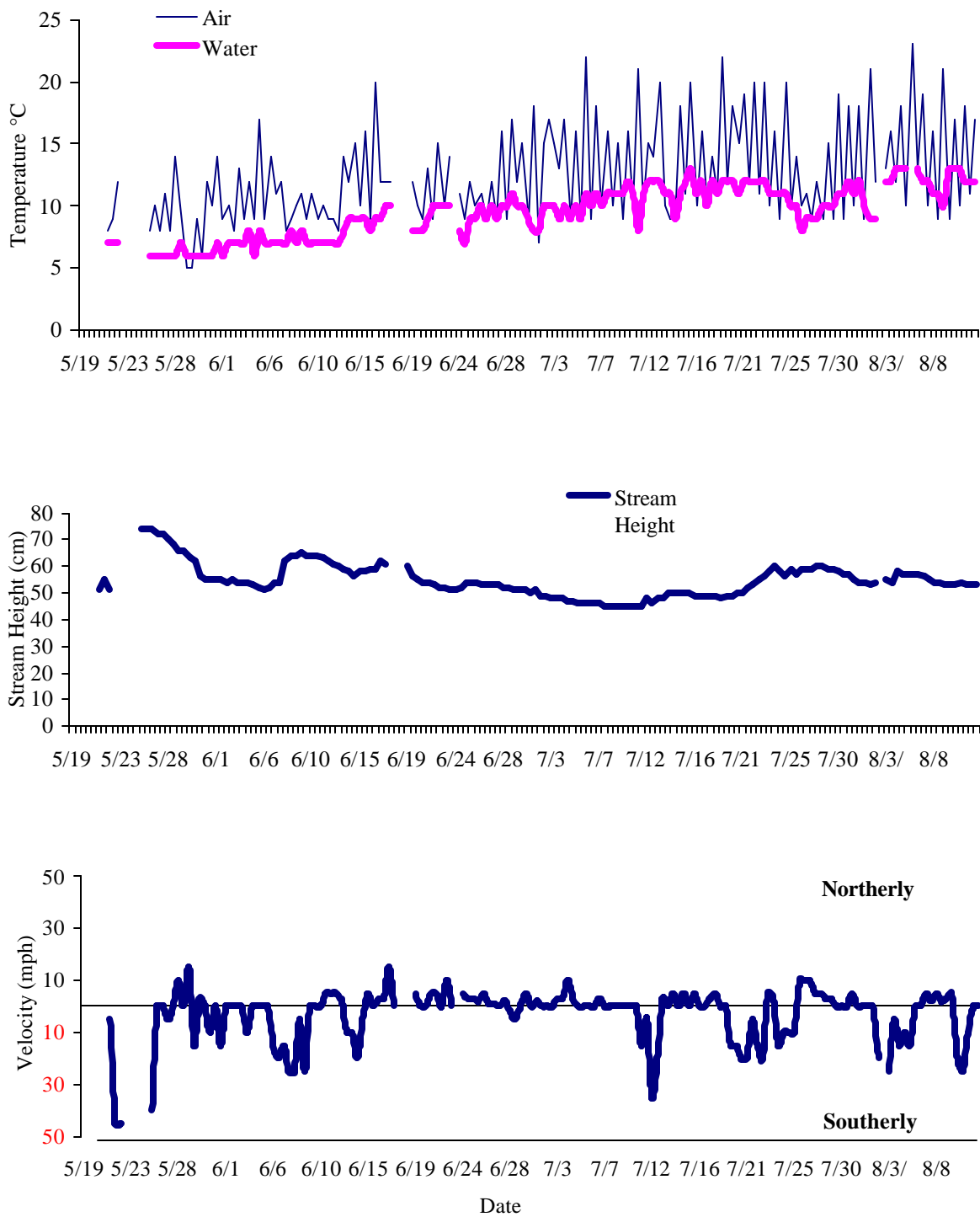


Figure 9. Air and water temperature, stream gauge height, and wind velocity and direction data gathered at Bear River, 2002.

APPENDIX

Appendix A. Daily sockeye salmon smolt trap catches and mark-recapture results from the downstream inclined plane trap at Bear River, 2002.

Smolt Date	Catch		Mark-Recapture			
	Daily	Cumulative	# Released	Daily Recaptures	Cumulative Recaptures	% ^a
5/19	3	3				
5/20	9	12				
5/21	23	35				
5/22	17	52				
5/23	wash out	52				
5/24	wash out	52				
5/25	1	53				
5/26	2	55				
5/27	4	59				
5/28	7	66				
5/29	14	80				
5/30	13	93				
5/31	1	94				
6/1	18	112				
6/2	12	124				
6/3	6	130				
6/4	2	132				
6/5	0	132				
6/6	0	132				
6/7	360	492				
6/8	148	640				
6/9	5	645				
6/10	0	645				
6/11	2	647	119	0	0	0.8%
6/12	48	695		0	0	0.8%
6/13	63	758		0	0	0.8%
6/14	46	804		0	0	0.8%
6/15	43	847		0	0	0.8%
6/16	35	882		0	0	0.8%
6/17	40	922		0	0	0.8%
6/18	492	1,414		0	0	0.8%
6/19	39	1,453	1,000	6	6	0.7%
6/20	16	1,469		1	7	0.8%
6/21	420	1,889		0	7	0.8%
6/22	25	1,914		0	7	0.8%

^a Calculated by: $\% = \{(M+1)/(R+1)\} \times 100$;
where: M = number of marked fish, and;
R = number of marked fish recaptured (Carlson et al. 1998).

Appendix B. Daily sockeye salmon smolt trap catches and mark-recapture from the floating inclined plane trap at Bear River, 2002.

Smolt Date	Catch		# Released	Mark-Recapture		% ^a
	Daily	Cumulative		Daily Recaptures	Cumulative Recaptures	
6/23	387	387	1,000	61	61	6.2%
6/24	338	725		3	64	6.5%
6/25	1,283	2,008	1,000	49	49	5.0%
6/26	1,264	3,272		6	55	5.6%
6/27	1,872	5,144	1,000	18	18	1.9%
6/28	781	5,925		2	20	2.1%
6/29	920	6,845		2	22	2.3%
6/30	992	7,837	920	25	25	2.8%
7/1	205	8,042		6	31	3.5%
7/2	139	8,181		1	32	3.6%
7/3	283	8,464		2	34	3.8%
7/4	318	8,782	1,000	12	12	1.3%
7/5	148	8,930		7	19	2.0%
7/6	265	9,195		4	23	2.4%
7/7	298	9,493	1,000	21	21	2.2%
7/8	291	9,784		7	28	2.9%
7/9	277	10,061		3	31	3.2%
7/10	278	10,339		0	31	3.2%
7/11	1,040	11,379		1	32	3.3%
7/12	494	11,873		0	32	3.3%
7/13	186	12,059	1,000	21	21	2.2%
7/14	149	12,208		10	31	3.2%
7/15	1,463	13,671		6	37	3.8%
7/16	279	13,950		0	37	3.8%
7/17	548	14,498	950	10	10	1.2%
7/18	430	14,928		16	26	2.8%
7/19	1,205	16,133		1	27	2.9%

^a Calculated by: $\% = \{(M+1)/(R+1)\} * 100$;
where: M = number of marked fish, and;
R = number of marked fish recaptured (Carlson et al. 1998).

Appendix C. Daily sockeye salmon smolt trap catches and mark-recapture results the upstream stationary inclined plane trap at Bear River, 2002.

Smolt Date	Catch		# Released	Mark-Recapture		% ^a
	Daily	Cumulative		Daily Recaptures	Cumulative Recaptures	
7/2	139	139		1	1	NA
7/3	283	422		2	3	NA
7/4	653	1,075	1,000	61	61	6.2%
7/5	319	1,394		7	68	6.9%
7/6	718	2,112		5	73	7.4%
7/7	925	3,037	1,000	49	49	5.0%
7/8	1,568	4,605		19	68	6.9%
7/9	440	5,045		2	70	7.1%
7/10	483	5,528		0	70	7.1%
7/11	2,005	7,533		0	70	7.1%
7/12	4,788	12,321		0	70	7.1%
7/13	705	13,026	1,000	83	83	8.4%
7/14	295	13,321		18	101	10.2%
7/15	3,586	16,907		6	107	10.8%
7/16	922	17,829		2	109	11.0%
7/17	947	18,776	950	34	34	3.7%
7/18	1,014	19,790		6	40	4.3%
7/19	1,629	21,419		1	41	4.4%
7/20	67	21,486		0	41	4.4%
7/21	243	21,729		0	41	4.4%
7/22	189	21,918		0	41	4.4%
7/23	2,039	23,957		0	41	4.4%
7/24	1,692	25,649	1,000	86	86	8.7%
7/25	678	26,327		0	86	8.7%
7/26	304	26,631		1	87	8.8%
7/27	204	26,835		1	88	8.9%
7/28	144	26,979		1	89	9.0%
7/29	239	27,218		1	90	9.1%
7/30	914	28,132		0	90	9.1%
7/31	663	28,795		0	90	9.1%
8/1	346	29,141	450	8	8	2.0%
8/2	950	30,091		2	10	2.4%
8/3	127	30,218		1	11	2.7%
8/4	254	30,472		0	11	2.7%
8/5	351	30,823		0	11	2.7%
8/6	78	30,901		0	11	2.7%
8/7	129	31,030		0	11	2.7%
8/8	736	31,766		0	11	2.7%
8/9	362	32,128		0	11	2.7%
8/10	128	32,256		0	11	2.7%
8/11	429	32,685		0	11	2.7%

^a Calculated by: % = {(M+1)/(R+1)}*100;
where: M = number of marked fish, and;
R = number of marked fish recaptured (Carlson et al. 1998).

Appendix D. Daily weather and stream observations at Bear River, 2002.

Date	Time	Temperature (C)		Cloud	Wind		Gauge	Comments
		Air	Water	Cover (%)	Direction	Vel. (mph)	Height (cm)	
5/19	1200	12	7	0	SE	20	50	
	2400							
5/20	1200							
	2400	12	7	5	SE	10	50	
5/21	1200							
	2400	8	7	5	SE	5	51	
5/22	1200	9	7	100	SE	45	55	
	2400	12	7	25	SE	15	51	
5/23	1200							
	2400							
5/24	1200							
	2400							
5/25	1200							
	2400	8	6	95	SE	40	74	Rain
5/26	1200	10	6	100	-	0	74	
	2400	8	6	100	-	0	74	
5/27	1200	11	6	90	SE	5	72	
	2400	8	6	98	-	0	72	
5/28	1200	14	6	95	NW	10	70	
	2400	10	7	50	-	0	68	
5/29	1200	5	6	100	NW	15	66	
	2400	5	6	100	SW	15	66	
5/30	1200	9	6	100	NW	3	63	
	2400	6	6	100	-	0	62	
5/31	1200	12	6	100	SW	10	56	
	2400	10	6	80	-	0	55	
6/1	1200	14	7	100	SE	15	55	
	2400	9	6	95	-	0	55	
6/2	1200	10	7	100	-	0	55	
	2400	8	7	95	-	0	54	
6/3	1200	13	7	100	-	0	55	
	2400	9	7	100	SE	10	54	
6/4	1200	12	8	75	-	0	54	
	2400	9	6	20	-	0	54	
6/5	1200	17	8	25	-	0	53	
	2400	9	7	20	-	0	52	
6/6	1200	14	7	70	SE	15	51	
	2400	11	7	95	SW	20	52	
6/7	1200	12	7	100	SE	15	54	Rain
	2400	8	7	100	SE	20	54	
6/8	1200	9	8	60	SE	25	62	Rain
	2400	10	7	100	SE	5	64	
6/9	1200	11	8	100	SE	25	64	Rain, fog
	2400	9	7	100	-	0	65	Rain
6/10	1200	11	7	100	-	0	64	
	2400	9	7	100	-	0	64	
6/11	1200	10	7	100	NW	5	64	
	2400	9	7	100	NW	5	63	
6/12	1200	9	7	100	NW	5	62	
	2400	8	7	100	NW	2	61	fog

-Continued-

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Date	Time	Temperature (C)		Cloud Cover (%)	Wind		Gauge Height (cm)	Comments
		Air	Water		Direction	Vel. (mph)		
6/13	1200	14	8	50	SE	10	60	Sunny
	2400	12	9	5	SW	10	59	
6/14	1200	15	9	20	SE	20	58	
	2400	10	9	10	SE	5	56	
6/15	1200	16	9	60	NW	5	58	
	2400	9	8	30	-	0	58	
6/16	1200	20	9	30	NW	3	59	
	2400	12	9	30	NW	3	59	
6/17	1200	12	10	70	NW	15	62	
	2400	12	10	100	-	0	61	
6/18	1200							
	2400							
6/19	1200							
	2400	12	8	50	NW	5	60	
6/20	1200	10	8	100	-	0	56	
	2400	9	8	100	-	0	55	
6/21	1200	13	9	100	NW	5	54	
	2400	9	10	100	NW	5	54	
6/22	1200	15	10	100	-	0	53	
	2400	10	10	100	NW	10	52	
6/23	1200	14	10	100	-	0	52	
	2400			100			51	
6/24	1200	11	8	100	NW	5	51	Rain
	2400	9	7	100	NW	3	52	Rain
6/25	1200	12	9	100	NW	3	54	Rain
	2400	10	9	100	NW	2	54	Rain
6/26	1200	11	10	100	NW	5	54	Rain
	2400	9	9	100	NW	1	53	
6/27	1200	12	10	100	NW	1	53	
	2400	9	9	100	-	0	53	
6/28	1200	16	10	85	NW	3	53	
	2400	9	10	60	SE	2	52	
6/29	1200	17	11	50	SW	5	52	
	2400	12	10	100	-	0	51	
6/30	1200	15	10	100	NW	5	51	fog
	2400	9	9	100	-	0	51	
7/1	1200	18	8	100	NW	2	50	Rain
	2400	7	8	100	-	0	51	
7/2	1200	15	10	100	-	0	49	
	2400	17	10	100	-	0	49	
7/3	1200	15	10	100	NW	3	48	
	2400	13	9	100	NW	3	48	
7/4	1200	17	10	100	NW	10	48	
	2400	9	9	100	NW	3	47	
7/5	1200	16	10	100	-	0	47	
	2400	9	9	100	-	0	46	
7/6	1200	22	11	100	-	0	46	
	2400	9	10	100	-	0	46	

-Continued-

Appendix D. (page 3 of 4)

Date	Time	Temperature (C)		Cloud Cover (%)	Wind		Gauge Height (cm)	Comments
		Air	Water		Direction	Vel. (mph)		
7/7	1200	18	11	100	NW	3	46	
	2400	10	10	100	-	0	46	
7/8	1200	16	11	100	-	0	45	Rain
	2400	10	11	100	-	0	45	High, thin clouds
7/9	1200	15	11	90	-	0	45	
	2400	9	11	100	-	0	45	
7/10	1200	16	12	100	-	0	45	
	2400	10	11	100	-	0	45	
7/11	1200	21	8	60	SE	15	45	
	2400	10	11	75	SE	5	45	Sunny Afternoon
7/12	1200	15	12	100	SE	35	48	Wind off lake
	2400	14	12	80	SE	20	46	
7/13	1200	20	12	100	NW	3	48	
	2400	10	11	100	-	0	48	
7/14	1200	9	11	100	NW	5	50	dirzzle/fog
	2400	9	9	100	-	0	50	rain
7/15	1200	18	11	100	NW	5	50	High, thin clouds
	2400	11	12	100	-	0	50	
7/16	1200	20	13	70	NW	5	50	Brkn
	2400	10	11	100	-	0	49	High, thin clouds
7/17	1200	16	12	90	-	0	49	
	2400	10	10	100	NW	3	49	
7/18	1200	14	12	100	W	5	49	Low overcast
	2400	11	11	100	-	0	49	
7/19	1200	22	12	90	-	0	48	High, thin clouds
	2400	12	12	100	SE	15	49	
7/20	1200	18	12	100	SE	15	49	High, thin clouds
	2400	15	11	100	SE	20	50	
7/21	1200	19	12	75	SE	20	50	
	2400	12	12	75	SE	5	52	
7/22	1200	20	12	25	SE	15	53	Sun
	2400	11	12	100	SE	20	55	
7/23	1200	20	12	90	NW	5	56	
	2400	10	11	75	SE	3	58	
7/24	1200	16	11	100	SE	15	60	
	2400	9	11	100	SE	10	58	
7/25	1200	20	11	80	SE	10	56	
	2400	10	10	90	SE	10	59	
7/26	1200	14	10	100	W	10	57	Rain
	2400	10	8	100	NW	10	59	Rain
7/27	1200	11	9	100	NW	10	59	Rain
	2400	9	9	100	NW	5	59	Rain
7/28	1200	12	9	100	NW	5	60	Rain
	2400	9	10	100	NW	3	60	
7/29	1200	15	10	100	NW	3	59	
	2400	9	10	100	-	0	59	
7/30	1200	19	11	25	-	0	58	
	2400	9	11	15	-	0	57	fog
7/31	1200	18	12	5	NW	5	57	cavu
	2400	10	11	100	-	0	55	fog

-Continued-

Appendix D. (page 4 of 4)

Date	Time	Temperature (C)		Cloud Cover (%)	Wind		Gauge Height (cm)	Comments
		Air	Water		Direction	Vel. (mph)		
8/1	1200	18	12	0	-	0	54	cavu
	2400	9	10	5	-	0	54	
8/2	1200	21	9	0	-	0	53	
	2400	12	9	3	SE	20	54	
8/3	1200							
	2400	13	12	100	SE	25	55	
8/4	1200	16	12	100	SE	5	54	
	2400	12	13	100	SE	15	58	
8/5	1200	18	13	75	SE	10	57	
	2400	10	13	100	SE	15	57	
8/6	1200	23		80	-	0	57	Drizzle
	2400	13	13	100	-	0	57	
8/7	1200	19	12	100	NW	5	56	
	2400	10	12	100	NW	2	55	
8/8	1200	16	11	100	NW	5	54	
	2400	9	11	100	NW	2	54	
8/9	1200	21	10	100	NW	3	53	Rain
	2400	9	13	100	NW	5	53	
8/10	1200	17	13	90	SE	20	53	
	2400	10	13	40	SE	25	54	
8/11	1200	18	12	80	SE	10	53	
	2400	11	12	100	-	0	53	
8/12	1200	17	12	100	-	0	53	

Appendix E. Distribution list.

Individual	Organization	Address	# of copies
	Lake and Peninsula Borough	1577 C St. Suite 330 Anchorage AK 99501	1
Pat Martin	CAMF Member	2771 Deer Creek Rd Boseman MT 59715	1
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Bob Murphy	ADF&G	Kodiak ADF&G Office	1
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Mark Witteveen	ADF&G	Kodiak ADF&G Office	1
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Keith Weiland	ADF&G	Anchorage ADF&G Office	1
Warren Johnson	Bear Lake Lodge	Bear Lake (Via P. Moller)	1
Chris Boatright	FRI	UW-SAFS Box 355020 Seattle WA 98195	1

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